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Post-evaluation indicator framework for wind farm planning in China

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ABSTRACT

Compared with traditional fossil fuel energy, wind power is becoming more and more popular relies on its environment protected characteristic. In China, the wind power industry has undergone a rapid development based on the rapid development of wind power technology and the support from Chinese government policy. However, there is still a big difference between actual generating capacity and design data, which has caused a great impact on people's life and running of power grid. It is necessary to have a post-evaluation on wind farm planning. Based on studying domestic and foreign literatures that are about evaluation on wind farms, this paper gets a more comprehensive and integrated post-evaluation dedicator framework on wind farm planning. This framework consists of four indicators and ten sub-indicators, and also adds in evaluation study on management effect particularly, proposes a new evaluation perspective compared with the existing research.

Contents

1. Introduction

As a result of many national policies that used to promote renewable energy, China's total installed capacity of wind power doubled each year between 2006 and 2010.At the end of 2011, China's total installed wind capacity reached 62.73 GW, ranking the first place in world the second time after 2010 [1]. It can be forecasted that wind power will meet 17% of domestic electricity demand in 2050 [2].

However, despite of the rapid development of wind power installed capacity, the generating capacity does not show a similar increasing speed. M.Carolin Mabel have pointed out that the efficiency of qualified wind farms can be as much as 95–98%, while

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it is only about 75% in China; The design capacity factor of China's wind farms is about 0.25–0.30, but the actual capacity factor is often lower than this number [3]. Therefore, aiming to improve efficiency of wind farms in China, it is necessary to have a post-evaluation on wind farm planning, which can contributes to a better efficiency of planning work. Since experiences and lessons can be summed up through effective evaluation, so it can helps to guide and improve future work of wind farm planning. Carrying out the post-evaluation on designing wind farm, is to analyze and summarize the work that had been done during this period, seeking problems exposed in this process. Improve the effect of wind farm planning work and the efficiency of wind power generation by learning from post-evaluation result.

Although there are many studies on wind farm planning evaluation have been done: Shen and Wang proposed using three technical indicators, that is wind turbine distribution coefficient, wind resources and loss coefficient to evaluate operation situation of wind farms [4]; Gokcek et al. carried out post-evaluation studies on wind farms in Turkey in terms of economic [5]. But in authors' understanding, there has no post-evaluation study been carried out on the result of wind farm planning, little work has ever described and analyzed such an important issue based on a complete set of indicators. On the basis of analyzed and assessed the existing literatures about wind farms [6–15], this study extracts indexes about wind farm planning and constructs a post-evaluation index system with these indexes. Finally, each indicators and sub-indicators are analyzed in detail.

2. Development of wind power

2.1. Development of global wind power

Since the mid-1970s, fossil energy resources has became depleting, by the driving of environment protection and economic interests, the developed countries and some developing countries have paid much more attention to development and utilization of wind energy. Especially since the 1990s, wind power developed fast and the global wind power installed capacity has increased rapidly. According to statistics announced by Global Wind Energy Council (GWEC), the number of incremental installed capacity of global wind power industry achieved 41,000 MW in 2011, and the number of cumulative installed capacity was as much as 238,000 MW, which means the annual growth rate of incremental and cumulative installed capacity were 6% and 21% respectively. So far, there are 72 countries have wind power for commercial use, 22 countries of which have the installed capacity more than 1 GW. The number of global wind power installed capacity is shown in Fig. 1.

D.V.Giri, chief of Indian Wind Turbine Manufactures Association introduced that until the end of 2011, the number of installed capacity of wind power in Indian had been more than 16,000 MW. "In 2011, the number of incremental installed capacity of wind power in Indian is 3 GW, which has a significance meaning for the development of wind power industry. It can be forecasted that this number will achieve 5 GW in 2015. More and more private investment will be involved into this industry under the government's incentive policies". In 2011, the number of installed capacity in European Union was 9616 MW, and the cumulative installed capacity achieved 93957 MW. Data from The European Wind Energy Association(EWEA) shows that the installed capacity can satisfy 6% of the total electricity consumption in European. Experienced dilemma in 2010, wind power in the United States had a little rebound, the number of installed capacity in 2011 achieved 6800 MW. "Development foundation of US wind power is solid". Denise Bode, CEO of America Wind Energy Association (AWEA) declared, "the installed capacity in last year takes up 1/3 of the cumulative capacity in those years, we believe the expectation that in 2030 wind power can provide 20% electricity in US will come true. The newly increased installed capacity of wind power can offer about 2,000,000 families' power consumption". The emerging wind power industry in Latin America also had a good performance, the number of newly increased wind power installed capacity achieved 1200 MW. Brazil is the outstanding one among Latin America, whose incremental was 587 MW and cumulative capacity was 1500 MW in 2011.

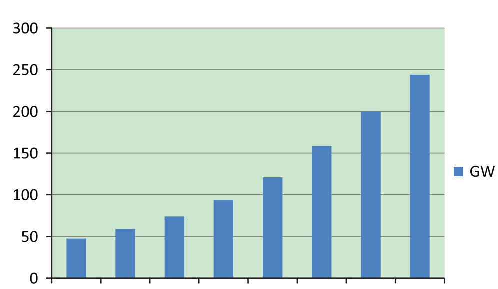


Fig. 1. Global wind power installed capacity (source: Europe wind energy association).

2.2. Development of wind power in China

According to the China Wind Power Safety Supervision Report, from 2006 to 2010, the number of wind power installed capacity in china got doubled continuous in five years, China has become the first in wind power installed capacity. Report announced by Global Wind Energy Council (GWEC) showed that, in 2011, the incremental of China wind power installed capacity was 18 GW, accounting for 40% of global incremental. The number of cumulative installed capacity in china has achieved 62.7 GW. Statistic from State Grid Corporation of China (SGCC) showed that, to the end of 2011, the number that SGCC absorbed wind power was about 70 billion kwh, increased by 49% compared with the number in 2010. Fig. 2 shows increased and accumulate installed capacity of wind power in China. It is forecasted that in 2015, the number of wind power installed capacity will achieve 100 million kw, and at that time, wind power will account for more than 3% of all the electrical energy. Fig. 3 shows the top 10 countries of increased installed capacity in the end of 2009.

2.3. Problems exposed in China wind power industry

Although is in the first place of installed capacity in global wind power industry, wind power industry in china has exposed severe overcapacity problems since 2009, what is more, wind power equipments are also overproducing in China. At present, strong growth of installed capacity covered those severe problems, actually, there are still almost 20 GW generating capacity cannot be absorbed. A researcher from China State Grid Energy Research Institute said that, contradiction between wind power quality and development speed, contradiction between standards

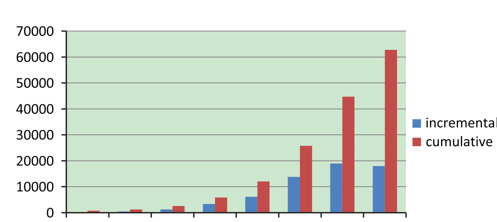


Fig. 2. Increased and cumulative installed capacity in China (MW) from year 2004 to 2011 (Source: CWEA).

lag and rapid growth of wind power, as well as problems such as uncoordinated of wind power and power grid, wind power and conventional energy are more and more serious.

The explosive growth of installed capacity over past few years makes China wind power industry the first place in world, but in terms of industry refined and maturity, there's still a big distance to the world advanced level. Compared with European and America, wind power industry in china is at the stage of extensive operation, problems such as low management ability, coarse technical process, low product quality and unsound of relevant standards are common. The wind power enterprises in China have to make a change and have a big breakthrough from aspects of management, values and technological innovation.

However, a number of research work are focusing on technological innovation, ignoring the importance of management and pay no attention to management, the research in this article aimed at improve management ability, helps to standardize process of wind farm planning, promotes the development of wind power in China.

3. Analysis on post-evaluation indicator of wind farm planning

Post-evaluation study on wind farm planning, is evaluate the planning work, the guiding ideology and optimization of general design plan, judge the scientific nature of design, feasibility of advanced technology and the accuracy of budget estimates. Literature review was carried out in this paper to identify the indicators and sub-indicators, so as to establish an evaluation system.

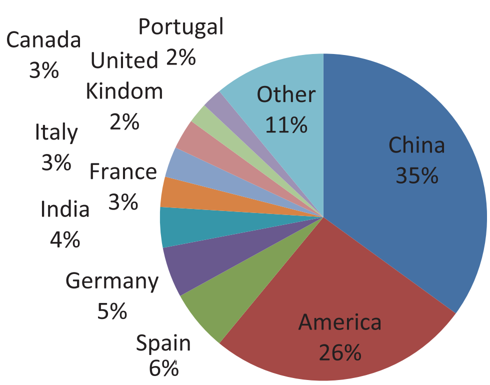


Fig. 3. Top 10 countries of increased installed capacity in the end of 2009 (Source: CWEA).

3.1. Indicator selection

Since research about this aspect is limited, this article choose relevant content, listed all the indicators in Fig. 4. According to the occurrence times of each index, selected out those indicators can be used in evaluating wind farm planning: wind resources, sites, equipments, policies, management, uncertainty factors, power demand and production, economics, impact on visual environment, connection with power grid and road.

3.2. Indicator sorting

American Wind Energy Association [16] (2007) listed the most important 10 steps in building a wind farm: understanding wind resource, determining proximity to existing transmission lines, securing access to land, establishing access to capital, identifying reliable power purchaser or market, addressing site and project feasibility considerations, understanding wind energy's economics, obtaining zoning and expertise, establishing dialog with turbine manufacturers, and securing agreement. To build more comprehensive and objective evaluation indicators, taking content from AWEA into consideration, classified those indicators into four aspects based on its attributes and character: function design evaluation, risk prediction evaluation, investment estimation evaluation, management effect evaluation. The post-evaluation indicators are listed in Fig. 5.

4. Indictor analysis

4.1. Function design

Function design, includes wind resource forecasting, macro-micro site selection, hardware's installation and usage and whether power system achieve desired safety. Evaluation on function design aims at looking for deficiency that may leads to

indicators	Fausto Cavallaro al. (2005)[9]	Huaiwu Peng (2009)[10]	Huaiwu Peng (2009)[11]	Amy H.I. Lee (2009)[12]	Jingyi Han (2009)[13]	Leda-Ioanna Tegou (2010)[14]	Carlos Pestana Barros (2011)[15]
Wind resource	✓	✓	✓	✓	✓	✓	✓
Wind farm site	✓		✓	✓	✓		✓
Wind turbine		✓		✓	✓		✓
Management effect		✓					✓
Maintainance		✓					
Uncertainties		✓		✓			
Electricity demand	✓					✓	
Electrical energy production	✓		✓				
Economic aspects	✓			✓	✓		
Visual impact					✓	✓	
Distance from electricity grid				✓		✓	
Distance from road network				✓		✓	
Policy support				✓	✓		✓

Fig. 4. Evaluation indicators about wind farm planning.

aspect	indicator	Sub-indicator
Founctional design	Wind farm selection	Wind resource assessment
		Analysis on grid-connected conditions
		Analysis on traffic conditions
		Study on local terrain and geological conditions
		Land acquisition and impact on environment
	Generating equipment selection	Electricity load demand assessment
		Selection of wind turbine equipment
		The arrangement and installment of wind turbines
Risk prediction	Internal risk	
	External risk	National policy analysis
Investment estimation	Equipment costs	
	Installation costs	
Management effect	Continuity of management	
	Progress controlling	
	Management on contract	
	Management on communication	

Fig. 5. Post-evaluation indicator framework of wind farm planning.

the deviation of expected generation capacity and actual generation capacity.

4.1.1. *Analysis on wind farm selection*

Thomsen et al. has compared potential for site-specific design of MW size wind turbines installed at different sites. The result showed that the variation in aerodynamically driven loads and energy production could be more than 50% between different sites [17]. Fuglsang and Thomsen has presented a method for site-specific design of wind turbines and compared a 1.5 MW stall regulated wind turbine in normal onshore flat terrain with a offshore wind farm and showed a potential increase in energy production of 28%, installation cost reduced by 10.6–4.6% to offshore wind farm [18]. Connection with electric networks, influence of wind turbines' height above ground, effect of wind gusting and micro sitting of WEGs are also main influences of annual energy output [19]. Thus, successful site selection is critical for optimization of wind farm planning. Sub-indicators of wind farm planning can be divided into: wind resource assessment, grid-connected analysis, traffic conditions analysis, topography and geological conditions analysis, land acquisition analysis and impact on environmental analysis.

1. Assessment of wind resource
   The main indictors that can reflect wind resource whether rich or not are: annual average wind speed, wind power's effective usage hours, capacity factor, etc. The larger these indicators are, the more abundant the wind power is. What is more, high-quality wind resource is also necessary, which requires for more stable wind direction, smaller changes in wind speed, less weather disasters and smaller intensity of turbulence. The study of geographical distribution of wind speeds, characteristic parameters of the wind, topography and local wind flow and

measurement of the wind speed are also very essential in wind resource assessment for successful application of wind turbines.

2. Grid-connected analysis
   The selected site should be as close to grid as it could, thus can reduce investment and circuit losses in grid engineering, also can meet voltage decrease requirement. What's more, enough capacity and good quality of power grid is also required, so as to avoid the damaging effects on the grid caused by wind farm's random output or stop running.
3. Analysis on traffic conditions
   Traffic and transportation conditions of the selected wind farm should be taken into consideration. Whether is convenient for equipment's transportation, whether the carrying burden of road is suitable for wind turbines and other transport vehicles, that is, the road used for transporting wind turbine should reach three or four level at least.
4. Terrain and geological conditions analysis
   The more complex terrain condition is, the more serious turbulence phenomenon will be generated, which is adverse for the output of wind turbine. The geological conditions of selected site should also taken into consideration, whether are suitable for deep mining, housing construction adn installing wind turbines. The ideal foundation is rock, compact soil or clay, lower water table, smaller earthquake intensity; the ideal wind farm is a place surrounded by the wind, no steep; the slope of hillside should be less than 30° and a smaller turbulence.
5. Analysis on land acquisition and impact on environment

In process of land acquisition, we should pay attention to three aspects:

(1) Whether process of handling the procedures for wind farm construction site is smooth.
(2) Costs associated with land acquisition. In general, the cost should be absolutely less than 5% of total investment in wind power plant.
(3) Impact on local residents and the status of their proper placement. Since environmental regulation have become stricter all over the world, the impact assessment suggest that alternative sites, technologies, design, and implementation methods are considered as mitigating measures. The situation faced by electricity companies have become more complex and risk.

Local policies should be understood clearly, the site should not be located in the nature reserve. What is more, it should be far away from residential areas, occupying less vegetation and trying to have minimum impact on the surrounding. Areas within certain distance of urban and rural population centers are not suitable for wind farms. The wind farms do not pose any environmental hazard and nor will they create any social issues [20].

4.1.2. Generation equipment analysis

(1) Electricity load demand analysis
    Reasonable analysis on the electricity load plays an important role both for selection of wind turbine and rational use of wind power.
(2) Selection of wind turbine equipment
    Followed by determining the road capacity is selection of wind turbine. Adequate selection of wind turbine has a significance meaning for wind farm's good economic benefits. Performance of wind turbine is determined by a number of factors such as the surface integrity of the turbine blades and the wake interference [21]. Reliability of wind turbine is critical to the success of wind power project, because higher level of risks associated with poorer reliability such as increased downtime and increased maintenance costs [22]. Factors affect selection of equipment include following aspects: price, advanced technology, ability of manufacturers and suppliers' reputation.
(3) Arrangement and installment of wind turbines
    The arrangement of wind turbine is, under certain unit's model, number and sites, considering the impact of topography on wind speed and impact of wind turbine wake flow, choose the arrangement method of unit, so that wind farm can have a maximum generating capacity, which is related to the efficiency economic operation of wind farm directly.

Many attempts have been made in optimizing wind turbines positioning. As Bansal et al. proposed in their essay, 10 ha/MW can be taken as the land requirement of wind farms, including infrastructure [23]. Many conditions, such as the morphology of the terrain, the speed and the direction of the wind and the turbine size will specify the spacing between the wind turbines in a wind farm.

4.2. Risk prediction

Lee and Chen have explained, risk factors should be taken into consideration during the process of applying ANP/ BOCR model to select the wind farm sites [12]. The risk factors in wind farm planning can be divided into two kinds: internal risk and external risk. Internal risk means uncertainties caused by the unavoidable risks in implementation of project; external risk is the risk caused by government policies and regulations that have impacts on the industry. Therefore, we must make predictions on the risk of these two aspects in process of planning wind farm, thus ensure the smooth operation of wind farm.

4.2.1. Uncertainty analysis

Uncertainty analysis is evaluates degree of prediction accuracy on risk due to various uncertainties in wind farm's planning. The indicator include: uncertainty of wind resources, natural environment and working environment.

4.2.2. National policy analysis

Government plays a key role in fostering a sound renewable power market, especially when the current industrial environment is not mature. The rapid growth of wind power in China demonstrated that effective policies can influence industry and market [24]. Fig. 6 shows the successively promulgated policies and regulations on new energy of previous years [25–28], the listed contents revealed the part that have an impact on wind farm planning and wind power industry.

To promote the development of renewable energy, in 2006, China implemented the "Renewable Energy Law" and established legal status, the basic system and policy framework of renewable energy's development, treated renewable energy as a priority area in energy development, proposed total targets of renewable energy, feed-in tariffs, tariff classification, cost-sharing and special funds and other basic systems, in order to provide legal basis for renewable energy policy. According to the requirement of the Renewable Energy Law, the National Development and Reform Commission, Ministry of Finance and other relevant government departments formulated relevant policies, especially a more comprehensive policy system to support development of wind power.

Year	law	Main context
1995	China electric power law	DEAL with the Issue of energy resources exclusively. Explicitly points out that the government encourages and supports electricity generation from RE energy.
1998	Renewable Energy Law	Reaffirmed and reemphasized the strategic importance of RE technologies For optimizing the use of energy resources, reducing emissions levels, and improving environment
2005	Interim measures for management on wind farm construction and environment protecting	stipulated management on wind farm construction and environment protecting
2006	China Energy Conservation Law	RE development will be given higher priority for energy development
2007	Interim measures for deployment of renewable energy tariff’ s additional revenue	deployment of renewable energy tariff’ s additional revenue
2008	Newly revised China Energy Conservation Law	Resolve the increasing contradiction between current energy demand Associated with economic development and the environment.
2009	Interim measures for renewable energy price and cost-sharing management	Standardized management on price of wind power, implement the cost-sharing system in wind power continually
2010	China Renewable Energy Amendment Act	researching resource and planning development, guiding industry and supporting technology, Price management and cost compensation, economic incentives and monitoring measures, the legal responsibility

Fig. 6. Regulations about wind energy.

Therefore, an accurate analysis on national policy is essential to success of wind farm planning. Following are some laws and regulations that can affect the development of China’s wind power.

(1) Resource assessment
In 2003, the National Development and Reform Commission (NDRC) organized national wind energy resource assessment and wind farm planning, had a clear understanding of status of national wind energy resource. In 2007, in order to further understand the distribution and change of wind energy resources, commissioned China Meteorological Administration, by using of special funds for renewable energy development, responsible for carrying out the construction of national wind energy resources professional observation network, and use of the method of numerical simulation to conduct a comprehensive analysis and evaluation on wind resources, established a national database for national wind resource, creating conditions for the large-scale development of wind power.

(2) Price of wind power
China has always been trying to develop and improve the wind power price policies. Especially in 2003, the state implemented two pricing methods: bidding price in wind power concession projects and government approval price in non-tender projects. The implementation of “Renewable energy prices and cost-sharing administrative interim Measures” (NDRC Price [2006] 7) and “renewable energy tariff additional revenue distribute Interim Measures (NDRC Price [2007] No. 44)” had an exploration on price sharing mechanism of wind power. Currently cost of onshore wind power exploration is about 0.35–0.5 RMB/kwh, corresponding price level is set to be 0.51–0.61 RMB/kW. Under current price mechanism, ignoring the coal resources and environmental costs, both the cost and price level of wind power are higher than coal cost and electricity price level in China. The current state subsidy policy in wind power is, implement the feed-in tariff system at the unit of regional, and the part of wind power electricity price, which is above the price of coal desulfurization, is stipulated to be paid by renewable energy development fund. In addition, wind power subsidy standards (0.01–0.03 Yuan/kW) have been also identified according to length of the wind farm’s transmission line.

(3) Equipments’ domestically
The “speed up the revitalization of equipment manufacturing industry views”, issued by State Council, put forward the demand of a number of large equipment manufacturing with highly competitive, enhancing manufacturing capacity of major technical equipment with independent intellectual property rights, in which, the high-power wind turbine was set to be key areas where major breakthroughs should be achieved. To support the development of China’s wind power industry, in 2006, the National Development and Reform Commission, Ministry of Finance issued “to promote

the implementation of the views of wind power industry'' jointly, cleared that special funds of renewable energy development could be used to support on the autonomy of wind power equipment manufacturers. In fact, the autonomy of wind power equipment was promoted and realized by the way of national concession projects positively and effectively.

(4) Management on construction
NDRC organized more than 20 construction management approach and technical requirements, including phases of wind energy resource's assessment, wind farm planning, and feasibility study, made a specification on the wind farm project planning, pre-work, development rights, the approval process, construction and operational requirements, thus forming a more complete wind power construction management and technical standards initially.

(5) Service system
To achieve independent development of wind power, the state decided to support the construction of wind power industry's public service system, to promote the research base of wind power technology, to support the establishment of public experimental platform in wind power, the establishment of wind power equipment's test and certification system, to speed up training talents and enhance construction of wind power industry system, to improve the level of wind power technology and services, to support the development of equipment manufacturing enterprises in the way of providing market, to form the equipment capacity which are mainly composed of the domestic equipment manufacturing, to meet needs of large-scale wind power development and utilization.

(6) In terms of wind power's approval
In accordance with previous wind power project management regulations, the wind farms whose installed capacity is or above 50,000 KW should be reported to the NDRC and need their approval, the ones that is less than 50,000 KW needed to be filed in the NDRC and then approved by the local government. In the "twelve five" national planning, the first approved notification about wind power project's scheduling, announced that the approval of wind power will be put into the national unified plan formally, the wind farm project should be approved by the provincial government investment departments, according to the wind farm construction plan and annual development plan that recorded in the report of the National Energy. The wind farm without the approval of specified procedures and conditions starting construct, cannot get the price subsidies supported by state's renewable energy development fund, the grid companies should not accept its network operation, once the illegal unauthorized construction projects was discovered, will be ordered to stop constructing by the provincial level energy authorities, and the responsible person shall be punished and blamed.

(7) In terms of grid-connected
In August 5th 2011, the National Energy Board approved and issued "the grid-connected design and technical specifications of large-scale wind farms" and other 17 key standards. In addition, in the national standard of wind power grid-connected technology, "technical requirements on wind power's grid-connected system", much more and stricter standards were made for wind turbines' reactive power compensation and access to test items. At the same time, the SERC launched nationwide security checks of wind power in August, mainly for the detection of wind turbine units' low-voltage ride through capacity, the situation of reform and the investigation on wind farm impact on the local power grid after accessing to system, which aimed at increasing the grid-connected capacity of wind power [29].

4.3. Investment estimation

The estimation of investment deviation, mainly assesses the bias between expect value and actual value in investment, aims to identify reason of deviation, and provides a reference and lesson for future investment. Wind farm investment costs consist of cost of foundation, electrical connection, grid connection, land purchase, planning, approvals, infrastructure, wind turbines, and management, and so on. As the most important part of wind power project, wind turbine unit accounts for 60–70% of a wind farm investment in China [30]. Taking characteristics of wind power projects into account, cost mainly occurs in equipment cost, so the index can be divided into the following two aspects:

(1) The deviation in estimating equipment cost
The change rate of investment in equipment=(actual cost of equipment—planning equipment cost)/ planning cost of equipment.

(2) The deviation in estimation installation cost
The change rate of Installation costs=(actual installation costs—planning installation costs)/ planning installation costs.

4.4. Management effect

In this study, evaluation on effectiveness of management is defined as, when the project is completed, evaluating management work on previous work, aiming at have a comprehensive summary of management experience, through analysis of the actual situation in implementation, do a favor for the improvement of future projects' management. Evaluation on management effectiveness is necessary and effective to improve the level of decision-making and management on projects. In the author's understanding, studies about evaluation on wind farm planning in current literatures is not much, content about management effect are less. Considered the fact that in wind farm planning, management effectiveness factor accounts for a large proportion, it is necessary to develop a evaluation study on this content, so that to effective evaluate planning of wind farm and management effectiveness, find out problems in management, improve management effectiveness, and eventually enhance decision-making ability.

According to characteristics of wind farm planning, evaluation index of the management effect can be divided into four aspects, shown in Fig. 7.

(1) Evaluation on the continuity of management
In the current design process of wind farm in china, because of reasons from developers' project management, the process of design is often interrupted, and little wind power project can be completed standardized by a specific design Institute from beginning of feasibility study to the end of construction [31], the discontinuities of the design will lead to the uncertainty of designed results. The non-uniform of design and content, would make the predicted wind resource and actual power generation volume not accurate, making the design level affected greatly.

(2) Evaluation on progress controlling
Completion of various tasks on time is critical for wind power projects, completing construction tasks according to the schedule, is helpful for both the running of wind power equipment and corporate getting profits as soon as possible, which have a great advantage for both government and the enterprises.

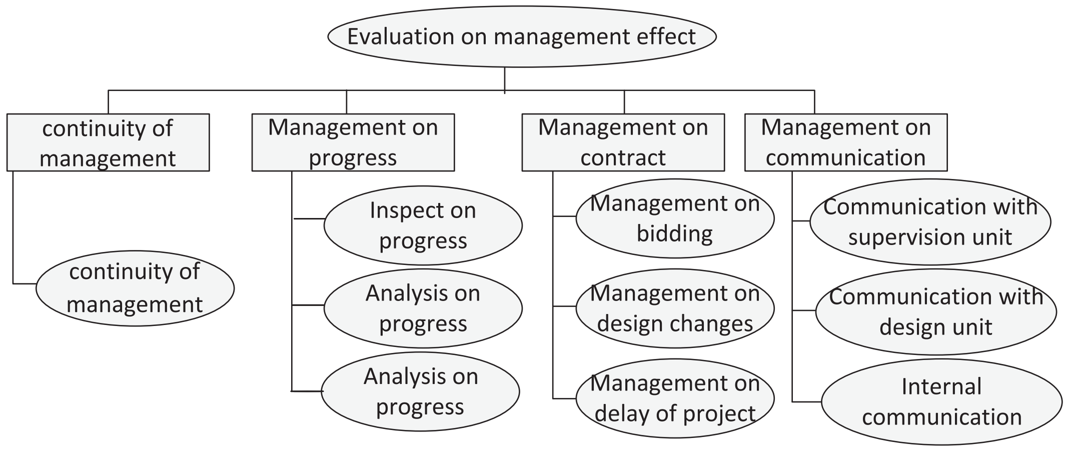


Fig. 7. Management effect evaluation indicator framework.

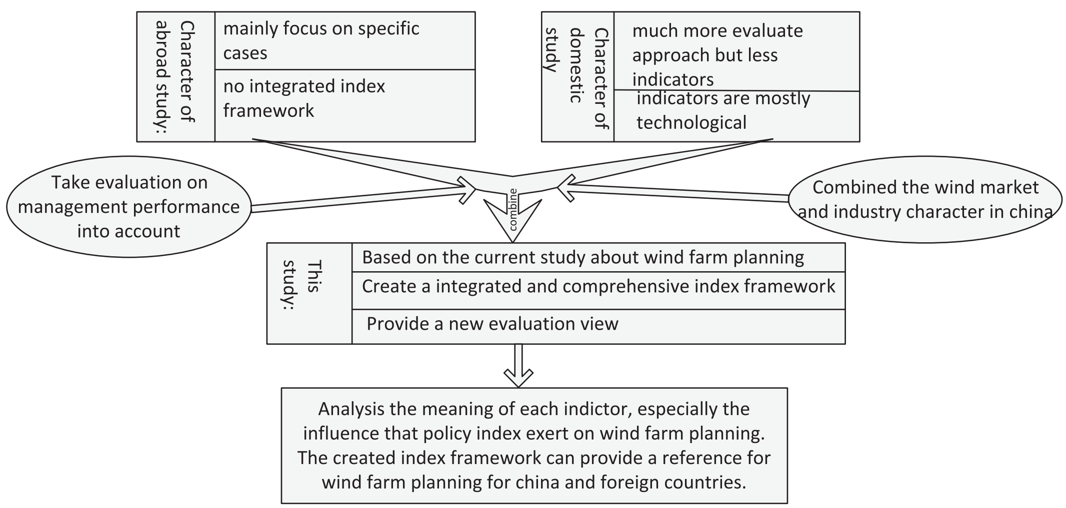


Fig. 8. Comparison between this study and previous studies.

For example, controlling on planning wind power project is an important aspect of management. The application for construction procedures usually controlled by government departments, relevant laws and regulations are numerous and complex, long procedure process and time span, but as long as pay greater attention on that and get prepared in advance, the pace of application progress can keep up with the pace of construction. This study chooses three indicators from the management on control on that progress.

(1) *Inspection on progress*. Progress of the project should be checked regularly, which is also an effective method for controlling progress, related check information should be recorded.
(2) *Analysis on progress*. Through the inspection on construction progress, based on discover of deviations, a further analysis should be made on the progress, which can provide a foundation for the progress's adjustment.
(3) *Adjustment on progress*. Where procrastination is discovered in the progress of work, and has an influence on follow-up activities and duration, the progress needed to be adjusted generally to achieve progress goals.
(4) *Evaluation on contract's management*. Contract documents are the fundamental basis for contract's management. In the planning period of wind farm, contract's management can be divided into management on bidding, management engineering design changes, management on delay of project. For example, in the process of purchasing wind turbines, the State Bidding Law must be followed strictly, do as what the tender law stipulates. If wind turbine equipment needs import, the international bidding method should be followed, do as the international common practice, choose better quality, superior performance and lower cost equipments by bidding. A good contract management is needed in the bidding process.
(5) *Evaluation on communication management*. Successful project management is inseparable from effective communication and coordination. Communication and coordination is not only exists within teams in a project, but also in numerous relevant stakeholders of construction project. These relevant stakeholders do not have same value, so there will emerge the phenomenon of disagreements and even conflict between them, communication and coordination is a good method of solving these problems in implementation of project, especially for planning wind farm. In this study, three evaluation indicators were chosen out: communication with supervision units, communication with design units, internal communication.

5. Conclusion

Fig. 8 shows a comparison between this study and previous study. Based on studying literatures that are about evaluation on wind farms, choose the indicators that can be used in post-

evaluation, and then integrated and optimized those indicators. Considering the importance of management effect for improve wind farm planning, evaluation on effect of management was added in particularly, getting an integrated and comprehensive post-evaluation index framework for wind farm planning, which took characteristic of wind farm planning and reality in china into account. At last, discussed evaluation indicators' meaning particularly, filled the vacancy in post-evaluation on wind farm planning currently. This framework provides a totally new evaluation perspective, which can not only reflect the performance of wind farm planning, analyze reasons of success or failure and summarize lessons, but also can provide some guidance for the future work.

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